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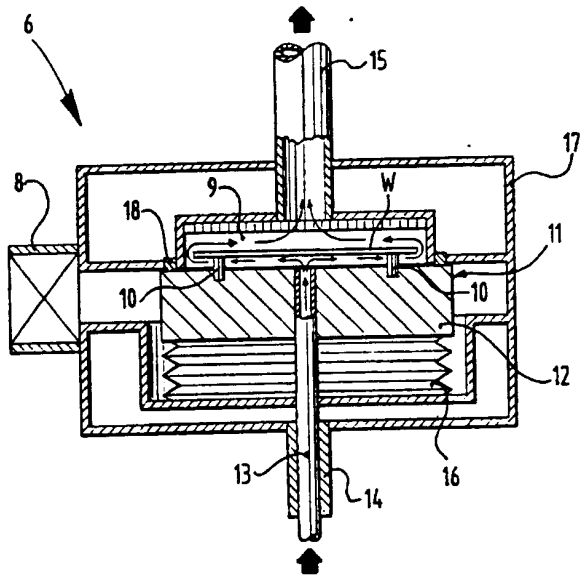

(57) Abstract

The present invention provides a device for treating a wafer of semiconductor material at a determined temperature with gas and/or vapour, comprising: a supply lock (7) for supplying a wafer (W) of semiconductor material; a treatment space (9) in which a wafer of semiconductor material can be placed via the supply lock; a gas inlet (13) for admitting gas and/or vapour into the treatment space; pump means for bringing the treatment space to and holding it at underpressure, and a table part (11) for supporting the wafer of semiconductor material having a mass relative to the surrounding parts such that during treatment an approximately constant temperature prevails in the treatment space.

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APPARATUS AND METHOD FOR TREATING A WAFER OF SEMICONDUCTOR MATERIAL

Arranging an image on the top surface of resist material is becoming increasingly popular and is known as Top Surface Imaging (TSI), as for instance the Desire® process described in Proceedings SPIE 631, page 34 (1986) by F. Coopmans and B. Roland. In addition to dry developing of the image, which must take place rapidly and anisotropically, the depositing of a silylation agent such as hexamethyldisilazane or trimethyldisilazane is also important. This must take place in a properly uniform manner while depth and profile of the indifusion of this silylation agent must be precisely determined. Further information cn be obtained from the above article.

In such processes the problem occurs that the temperature in a reactor in which such a process has to take place is difficult to keep constant. So called hot spots are to be avoided and atmospheric influence is to be minimised.

The present invention provides a device for treating a wafer of semiconductor material at a determined temperature with gas and/or vapour, comprising:

- a supply lock for supplying a wafer of semiconductor material at vacuüm or underpressure;
- a treatment space in which a wafer of semiconductor material can be placed via the supply lock;
- a gas inlet for admitting gas and/or vapour into the treatment space;
- pump means for bringing the treatment space to and holding it at underpressure; and
- a table part for supporting the wafer of semiconductor material having a mass relative to the surrounding parts such that during treatment a substantially constant temperature prevails in the treatment space.

In preference the gas inlet is situated on the rear side of the wafer of semiconductor material to be

positioned, so that there is no possibility that liquid droplets can form on the front side of the wafer of semiconductor material.

Also of great importance in keeping the treatment space at a constant temperature is the constant temperature of the gas to be admitted, for which purpose control means are arranged at the gas inlet, and valves and lines are heated in a controlled manner.

Further advantages, features and details of the present invention will become apparent in the light of the following description of a preferred embodiment thereof, with reference to the annexed drawings, in which:

fig. 1 shows a diagram of an arrangement in which a preferred embodiment of the device according to the present invention is incorporated;

fig. 2 shows a diagram of the apparatus of fig. 1; and

fig. 3 shows the apparatus of fig. 2 in a second position.

An arrangement 1 (fig. 1) comprises a transport area 2 which is held under vacuum and in which a schematically designated robot 3 is disposed for transporting wafers of semiconductor material out of a cassette 4 held under vacuüm to an etching reactor 5 and an apparatus 6 according to the present invention in which a so-called silylation reaction takes place. After the said treatment wafers of semiconductor material are transported by robot 3 to an output cassette 7.

The device 6 (fig. 2, 3) comprises a supply lock 7 in which wafers of semiconductor material W are fed into a treatment space 9 and from which, in the present embodiment, they are later also discharged. The wafer of semiconductor material is placed on pins 10 which form part of a table part 11, of which a block 12 also forms part which has a considerable mass of metal, for example stainless steel, compared to the surrounding parts of the device 6.

In the present embodiment the block of metal has a diameter of 26cm and a height of 10cm, such that the heat capacity of the metal table is at least two orders of

magnitude larger than a wafer of 98mm height and a diameter of 200mm. Preferably one table of stainless steel is covered with a tin layer of aluminium such as to increase thermal conduction to the wafer. The metal table is provided with fifteen heating elements of 750 watt each.

Arranged in the table part in a manner not shown are heating means - and measuring and control means for measuring and controlling the temperature -to bring the block of metal 12, the water and the treatment space 9 to the desired temperature in a temperature range of 30-250°C within a short period, for instance 10 seconds. A gas inlet 13 is further arranged through table part 11, which inlet is provided with only schematically designated temperature control means for accurate control of the temperature of the gas to be admitted. The gas is supplied on the underside of the wafer of semiconductor material W while a connection 15 to vacuum pumps is situated on the upper side of wafer W so that the admitted gas on the underside of wafer W flows radially outward and flows uniformly round the periphery of the wafer, with a diameter of for instance 200 mm, upwards to the outlet 15. After wafer W is placed on the pins 10 the whole table part is moved upward, preferably pneumatically by means of schematically designated concertina parts 16. Arranged in an uppermost portion 17 of the device 16 are sealing means 18 against which table part 11 seals in its topmost position so that treatment space 9 is brought in a short time to the desired underpressure, for instance to a desired underpressure of 10^{-4} Torr within 5 seconds. The device is further designed to operate to a pressure of 700 Torr.

Initial results with the shown and described device relate particularly to the above mentioned silylation process wherein good results are obtained in the submicron region with respect to bringing about diffusion of hexamethyldisilazane and trimethyldisilazane on exposed portions of a wafer of semiconductor material so that within such submicron dimensions SiO_2 can subsequently be applied there

under plasma treatment. For further details of this process reference is made to the above mentioned SPIE publication.

Example

After a pre-silylation bake at an underpresseure of 200 Torr and a N_2 flow of 20% and a time of 60 sec., a number of wafers were silylated using the above described apparatus and arangement at a temperature of 110°C, while the silylation agent (TMDS) which was introduced had a temperature of 30°C.

The uniformity of the thickness of the resist was measured to be within 1,5% at the thickness of 382-296 mm.

It is important to notice that by the arrangement according to the present invention it is possible to minimize the influence of the atmospheric environment, especially moisture, as the wafers are kept under vacuum (between 10^{-5} Torr and 750 Torr) between pretreatment and silylation (temperature 20-250°C)

The apparatus and method can be used for every type of resist that can be developed in a dry manner, especially TMDS and HMBS, and that are diffused selectively into certain parts (exposed or non-exposed) of the resist. The Desire® process is an example thereof.

It is noted that in addition to the inclusion of the table part with great mass, the shown and described device is embodied such that "isotherms" in the treatment space have a uniform progression.

It is further possible in a manner not shown to supply coolant to determined locations in the upper table part in order to obtain the desired uniform temperature profiling in the treatment space.

CLAIMS

1. Device for treating a wafer of semiconductor material at a determined temperature with gas and/or vapour, comprising:

- a supply lock for supplying a wafer of semiconductor material;
- a treatment space in which a wafer of semiconductor material can be placed via the supply lock;
- a gas inlet for admitting gas and/or vapour into the treatment space;
- pump means for bringing the treatment space to and holding it at underpressure; and
- a table part for supporting the wafer of semiconductor material having a mass relative to the surrounding parts such that during treatment an approximately constant temperature prevails in the treatment space.

2. Device as claimed in claim 1, wherein the table part has a mass such that in a temperature range of 30-250°C a temperature stability within 1°C is obtained.

3. Device as claimed in claim 1 or 2, wherein the constant temperature is reached within 10 seconds.

4. Device as claimed in any of the claims 1, 2 or 3, wherein the table part comprises a block of stainless steel.

5. Device as claimed in any of the claims 1-4, provided with means for moving the table part up and downward.

6. Device as claimed in any of the claims 1-5, wherein the gas inlet extends through the table part to a position behind the wafer of semiconductor material for arranging.

7. Device as claimed in any of the claims 1-6, wherein the gas inlet is provided with control means for controlling the temperature of the gas to be admitted.

8. Method for treating a wafer of semiconductor material with gas and/or vapour, wherein a device as claimed in any of the claims 1-7 is applied and wherein the gas comprises a silylation agent for acting on portions of the wafer of semiconductor material exposed to light.

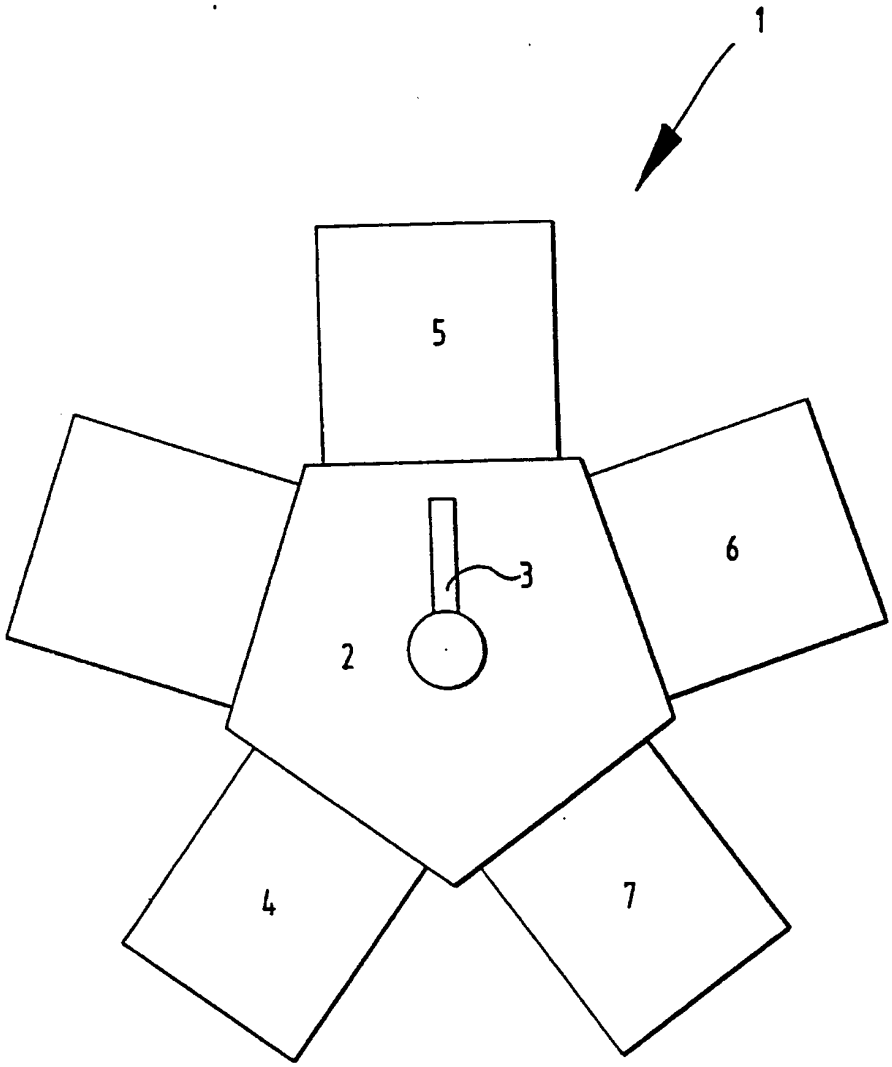

FIG. 1

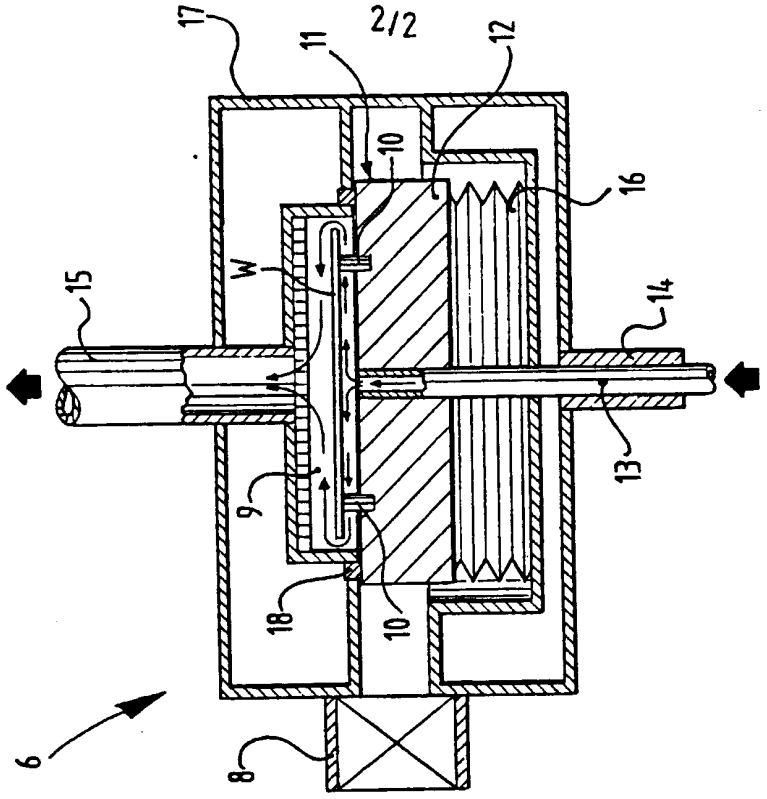

FIG. 3

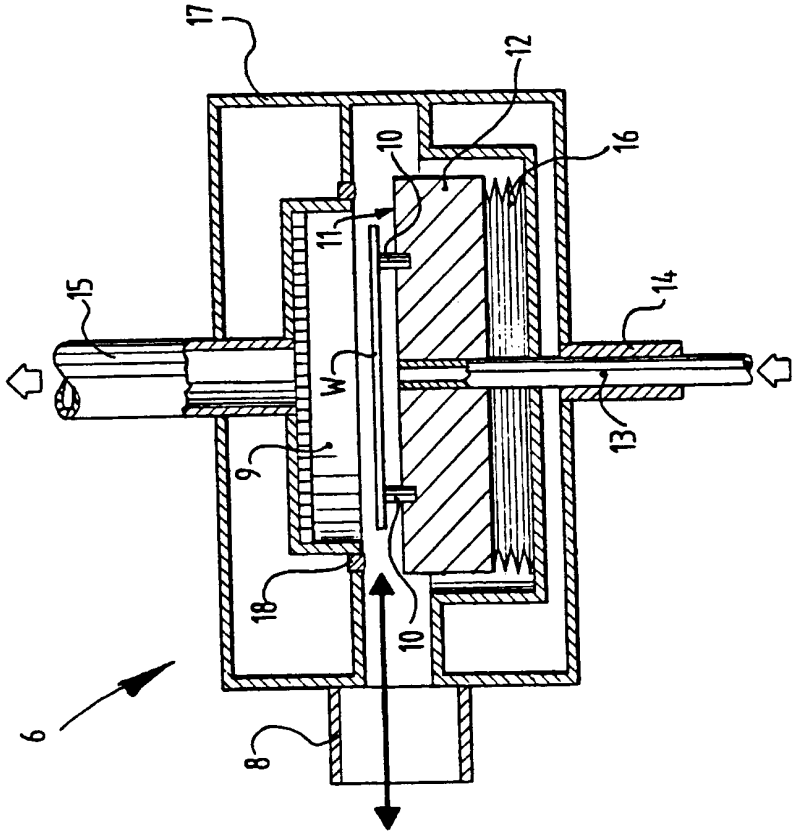

FIG. 2

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/EP 93/01779

A. CLASSIFICATION OF SUBJECT MATTER
IPC 5 C23C16/04 C23C16/44 C23C16/46

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 5 C23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A,5 060 354 (CHIZINSKY) 29 October 1991 see column 4, line 56 - column 6, line 11; figures 1-4 see column 7, line 7 - line 13	1,6
X	EP,A,0 467 624 (NOVELLUS SYSTEMS) 22 January 1992 see column 3, line 3 - line 58; figures 1,2	1,4,6
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 202 (C-129)(1080) 13 October 1982 & JP,A,57 110 665 (SUWA SEIKOSHA) 9 July 1982 see abstract	1,2

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
21 October 1993	18. 11. 93

Name and mailing address of the ISA	Authorized officer
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	PROCEEDINGS OF SPIE vol. 631 , 1986 , WASHINGTON, US pages 34 - 39 COOPMANS AND ROLAND 'DESIRE: a novel dry developed resist system' cited in the application see page 35, paragraph 2	8

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna al Application No
PCT/EP 93/01779

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-5060354	29-10-91	JP-A- 5152224	18-06-93
EP-A-0467624	22-01-92	US-A- 5133284	28-07-92